Space Weather Technical Forecast

Issued on Thursday, 31 March 2022 at 01:17 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of further M-class flares throughout. Slight chance of further S1 or above solar radiation storms. G1-G2/Minor-Moderate geomagnetic storms are expected on Days 1 and 2 (31 March and 1st April), with a Chance of a G3/Strong storm.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been at High levels over the past 24 hours, with an X1.3 class flare at 30/1737UTC, which originated from AR2975, subsequently resulting in R2-R3 radio blackouts, peaking at 30/1746UTC. The X1.3 flare from AR2975 has produced a coronal mass ejection (CME), which can be seen in STEREO-A, although awaiting further coronagraph imagery for analysis. However, given its location from STEREO-As view, the CME is likely to be Earth-directed, although pending analysis.

There are currently four numbered sunspots on the visible disc, with AR2976 in the northwest quadrant, currently the largest sunspot, but remains stable. Meanwhile, AR2975 (also in the NW quadrant) remains magnetically complex and continues to develop, with the presence of delta spots, and produced the recent X-class flare. AR2978 (Eho/Beta) continues to rotate across the SE quadrant, but remains stable. Other remaining sunspots are relatively small and magnetically simple.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, were mostly at slightly elevated levels, with a peak of 425km/s at 30/0223UTC. The density has been at below to average levels. The strength of the IMF, Bt, has been at weak at below 6nT. The north-south component, Bz, weakly variable mainly between +4 to -5 nT. The Phi angle has fluctuated between positive and negative orientation, ending the period negative (towards the Sun). Geomagnetic activity was mostly Quiet (Kp 1-2), with BGS showing one Unsettled (Kp3) interval 29/1500-1800 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) measured at GOES-16 continued a slow decline following the S1/Minor solar radiation storm on 28th March. Proton flux has recently become slightly elevated again at 10 MeV, with a further minor solar radiation storm possible into Day 1 (31 March).

The high energy (greater than 2 MeV) electron flux as observed by GOES-16 at GEO was at background to moderate levels, with a peak of 243pfu at 30/1540 UTC. The observed fluence at 31/0001 UTC was 4.38e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be mostly Low, with the chance of further M-class flares, and a slight chance of an X-class flare, mainly from AR2975.

Solar Wind / Geomagnetic Activity: The next enhancement is expected to come from the 28th

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March CME(s), which are anticipated to arrive, as a combined CME at Earth on Day 1 (31 March). CME effects are then expected to continue into Day 2 (1st April), before gradually weakening into Days 3 and 4 (2nd and 3rd April).

Quiet to Unsettled conditions initially, before Active to G1-G2/Minor-Moderate storm periods are expected on Day 1 (31 March), with the Chance (30%) of a G3/Strong Storm, and perhaps a Slight Chance (10%) of a G4/Severe Storm. Disturbed geomagnetic conditions are expected to continue into Day 2 (1st April), before gradually easing into Day 3 (2nd April). However, geomagnetic activity may remain Unsettled to Active Days 3 and 4 (2nd and 3rd April) due to a possible fast wind from a coronal hole(s) influence.

Energetic Particles / Solar Radiation: The continued activity of AR2975 in particular gives the slight chance of further potential enhancements above the S1 threshold during the period.
A flat trend is expected at first in the high energy (greater than 2 MeV) electron flux. However, from Day 1 (31st March) confidence becomes low, as the 28th March CME(s) are expected to arrive at Earth, and this is likely to at least temporarily reduce flux levels. Thereafter, some erratic fluctuation is likely, but with a possible eventual rise towards the end of the period. The associated 24 hour fluence is likely to remain below the Active (1e8 integrated pfu) threshold for much of the period.

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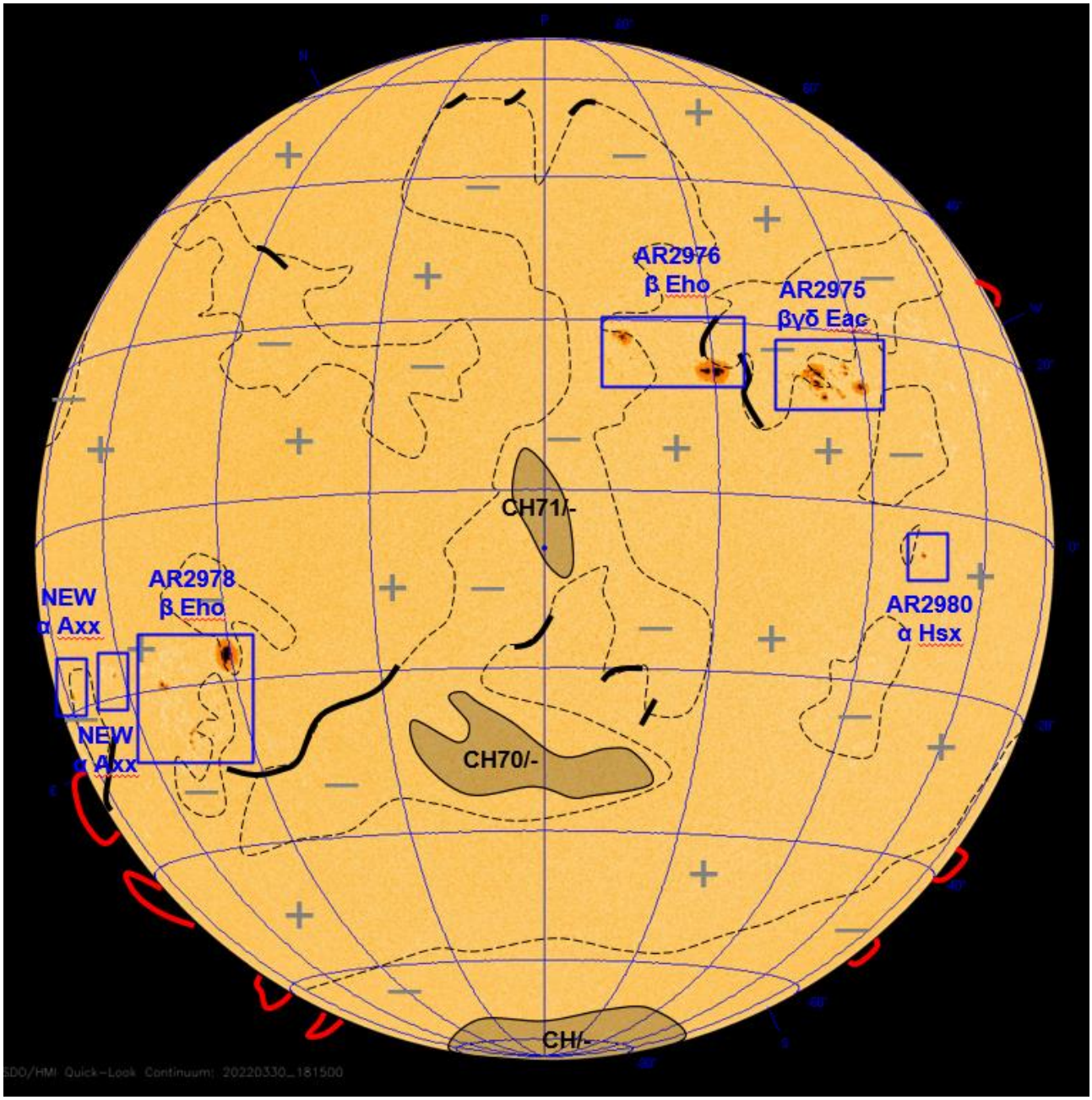
Figure 1. Solar Analysis Valid 30/1815UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Solar winds have been mostly at slightly elevated levels, with a peak of 425km/s at 30/0223UTC. The next enhancement is expected to come from the 28th March CME(s), which are anticipated to arrive, as a combined CME at Earth on Day 1 (31 March). CME effects are then expected to continue into Day 2 (1st April), before gradually weakening into Day 3 (2nd April).

Quiet to Unsettled conditions initially, before Active to G1-G2/Minor-Moderate storm periods are expected on Day 1 (31 March), with the Chance (30%) of a G3/Strong Storm, and perhaps a Slight Chance (10%) of a G4/Severe Storm. Disturbed geomagnetic conditions are expected to continue into Day 2 (1st April), before gradually easing into Day 3 (2nd April). However, geomagnetic activity may remain Unsettled to Active on Days 3 and 4 (2nd and 3rd April) due to a possible fast wind from coronal hole(s) influence.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	80	60	30	10
Strong	G3	No	30	30	5	1
Severe	G4	No	10	10	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
28/1624 UTC	Halo	M4 flare 28/1129 UTC	AR2975	550 km/s	31st March	G1-G2 expected, with a Chance of G3
29/0108 UTC	Halo	M1 flare 28/1920 UTC	AR2975	722 km/s	31st March	Combines with the above CME

Figure 2: MOSWOC Enlil shows the expected arrival of two 'combined' CMEs on the 31st March.

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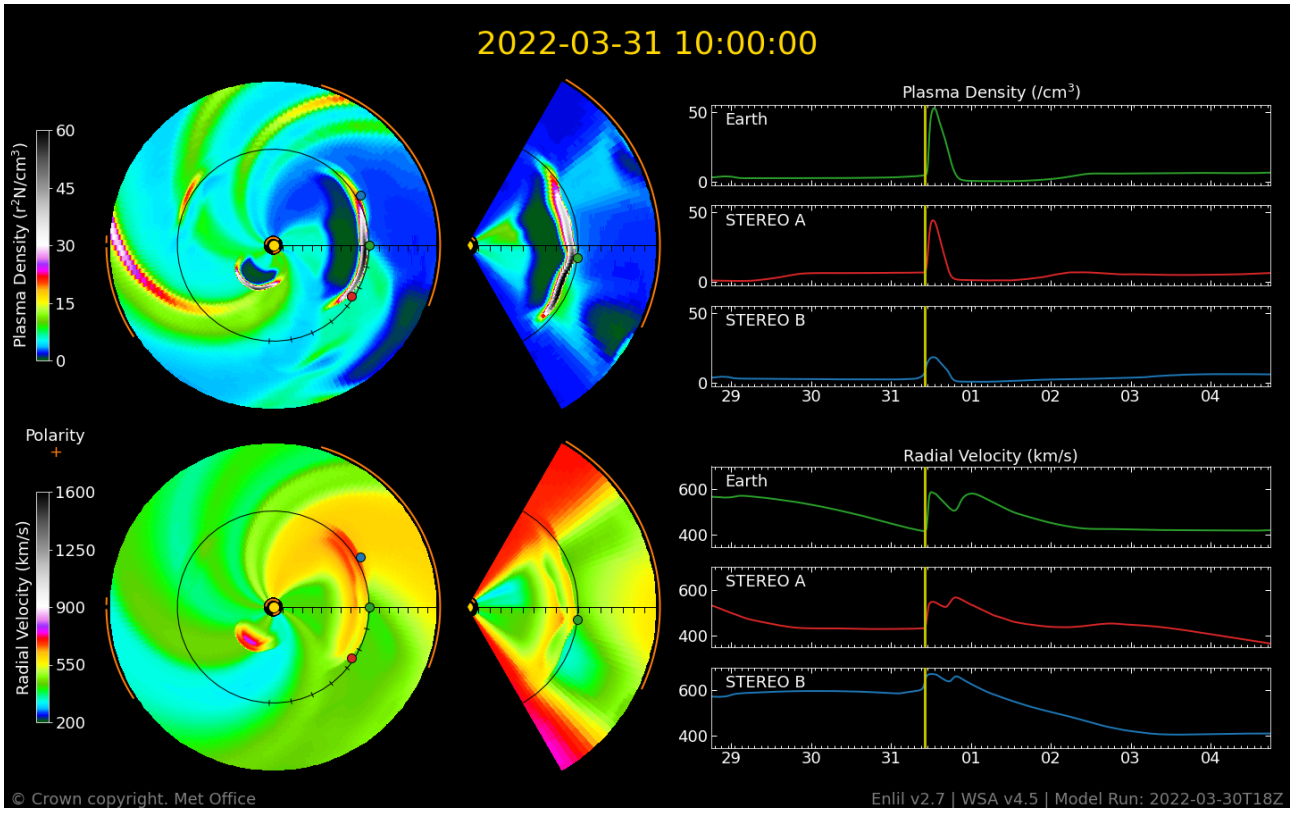
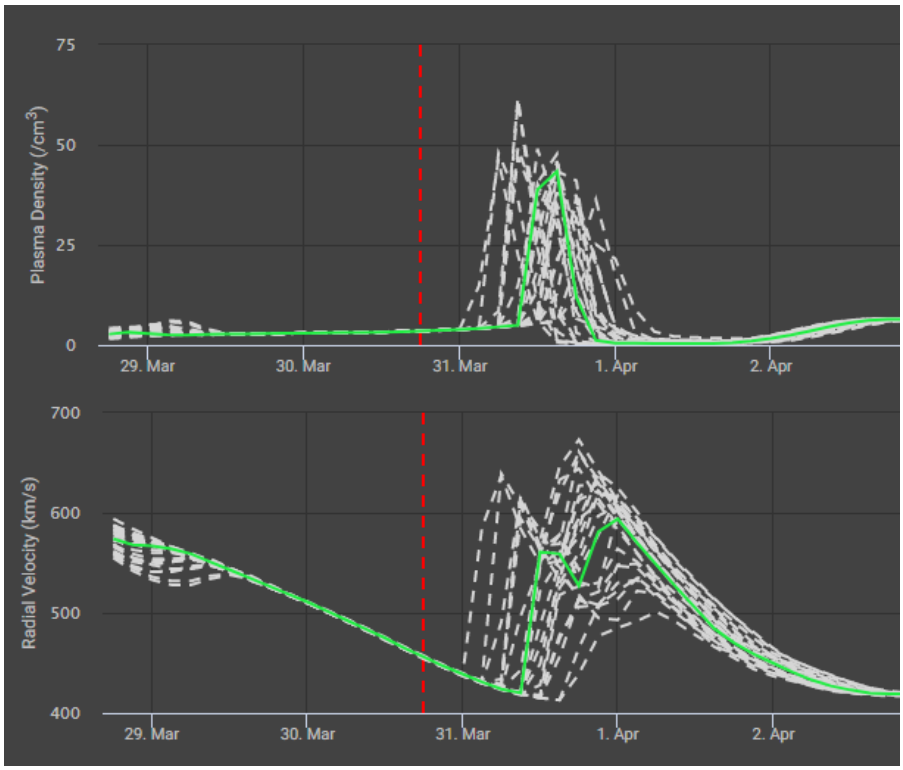


Figure 3: Enlil ensemble shows a range of possible arrival times.



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Radio Blackouts - X-Ray Flares:
Solar activity is currently at High levels, with an X1.3 class flare, peaking at 30/1737UTC, and originating from AR2975 in the northwest quadrant. This has produced a CME, observed in STEREO, but awaiting further coronagraph imagery to analyse for any Earth-directed component. Given its location, the CME seen in STEREO is likely to be Earth-directed, pending analysis.

There are currently four numbered sunspot regions on the visible disc. AR2975 (NW quadrant) remains magnetically complex and continues to develop, with coalescence of some of the intermediate spots and an increase in length. At least two delta spots are still evident. This region has recently produced the aforementioned X-class flare and CME. AR2976 also in the northwest quadrant is currently the largest sunspot, although remains stable. AR2978 (Eho/Beta) continues to rotate across the SE quadrant. The large lead spot unchanged, with some increase in its spots in the south of the region. AR2980 (Hsx/Alpha) in the southwest is small and stable. Two NEW regions have emerged to the east of AR2978 near the limb, these will be monitored for any further development.

Solar activity is expected to be mostly Low, but with the chance (50%) of further M-class flares, and a slight chance (10%) of an X-class flare, mainly from AR2975.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	50	50	50
Very Active	R3 to R5 X Class	Yes	10	10	10	10

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Figure 4: SDO/AIA 94 imagery shows the X1.3 flare from AR2975.

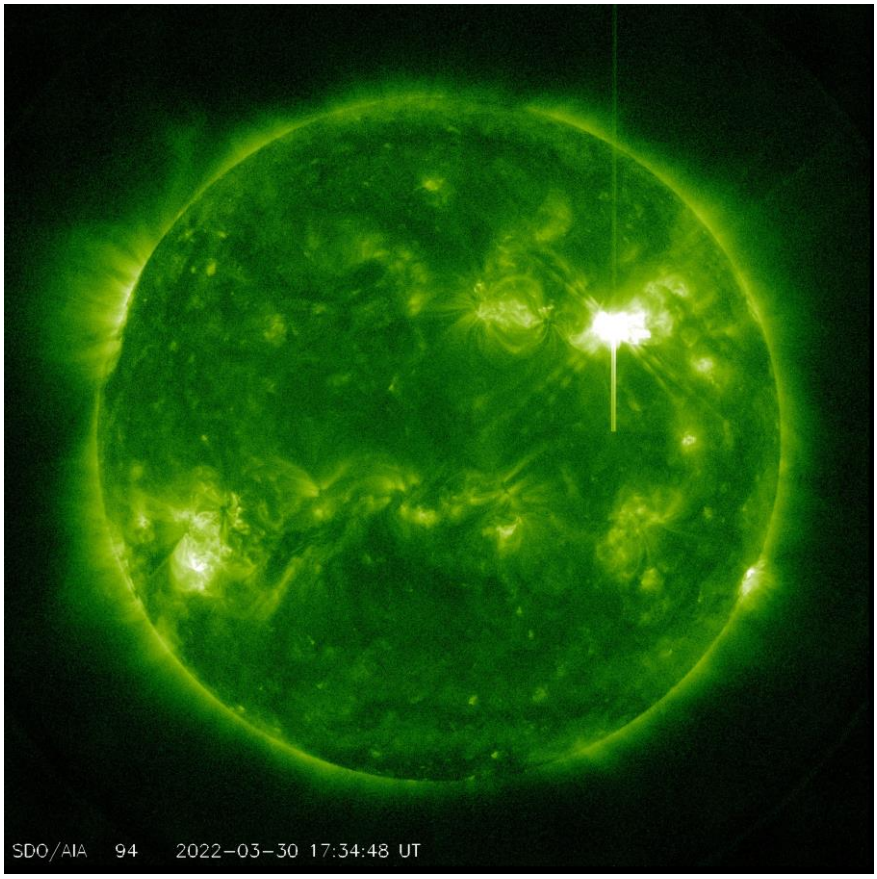

Figure 5: GOES-16 X-ray flares, which shows the X1.3 flare originating from AR2975.

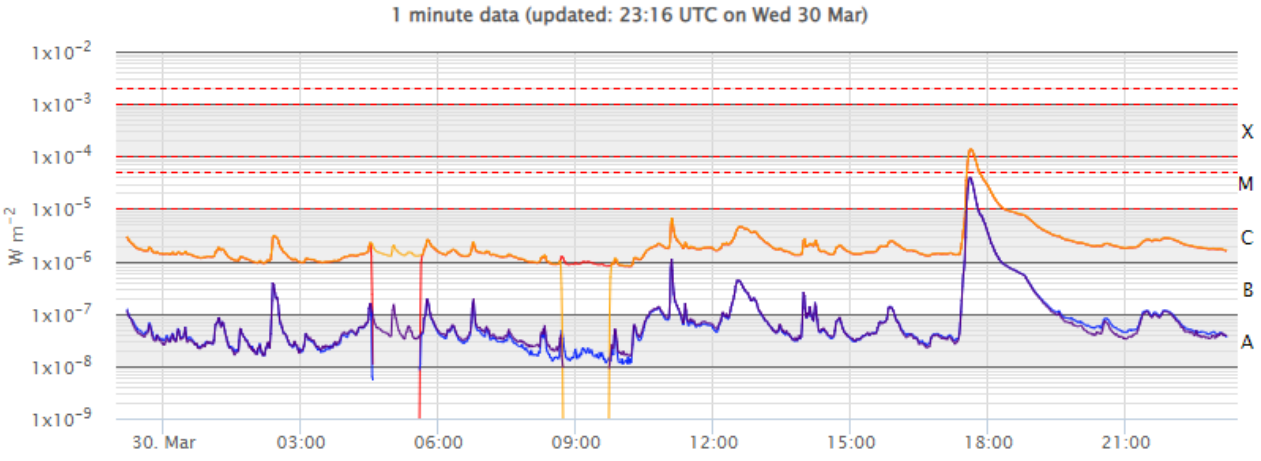

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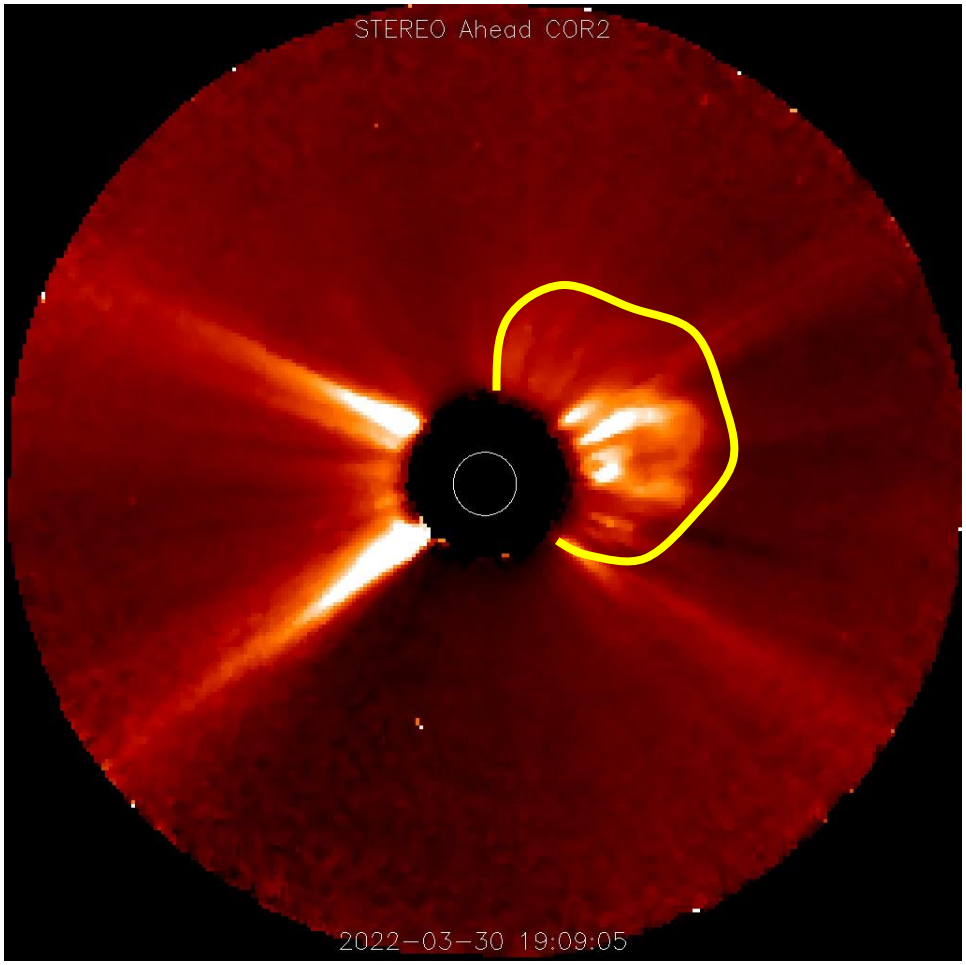
Figure 6: The X-ray flare from AR2975 has produced a CME, which was observed in STEREO-A (see below) – awaiting further imagery for analysis. Given its location, the CME is likely to be Earth-directed.



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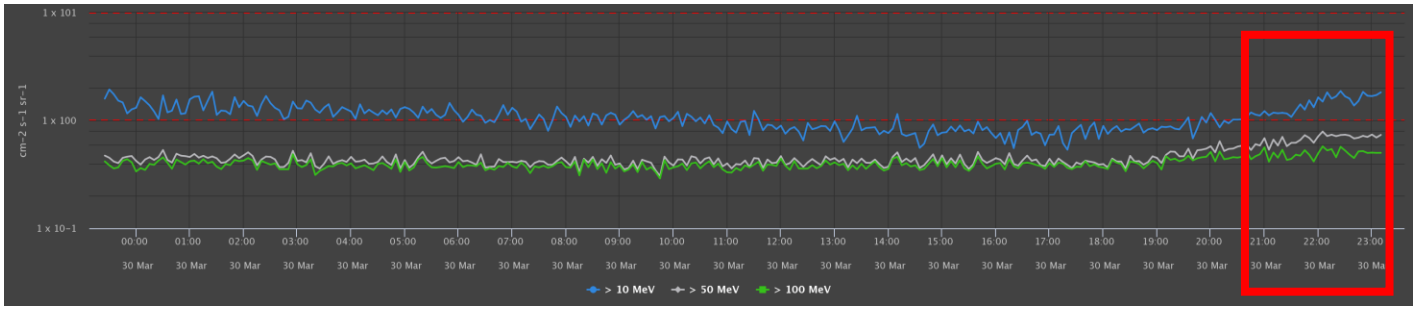
Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (10MeV) measured at GOES-16 continued a slow decline following the S1/Minor radiation storm on 28th March. The continued activity of AR2975 in particular gives the slight chance of further potential enhancements above the S1 threshold during the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	20	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 7: GOES-16 Proton Flux – shows a steady rise in protons at 10 MeV, probably due to the X-ray flare from AR2975.



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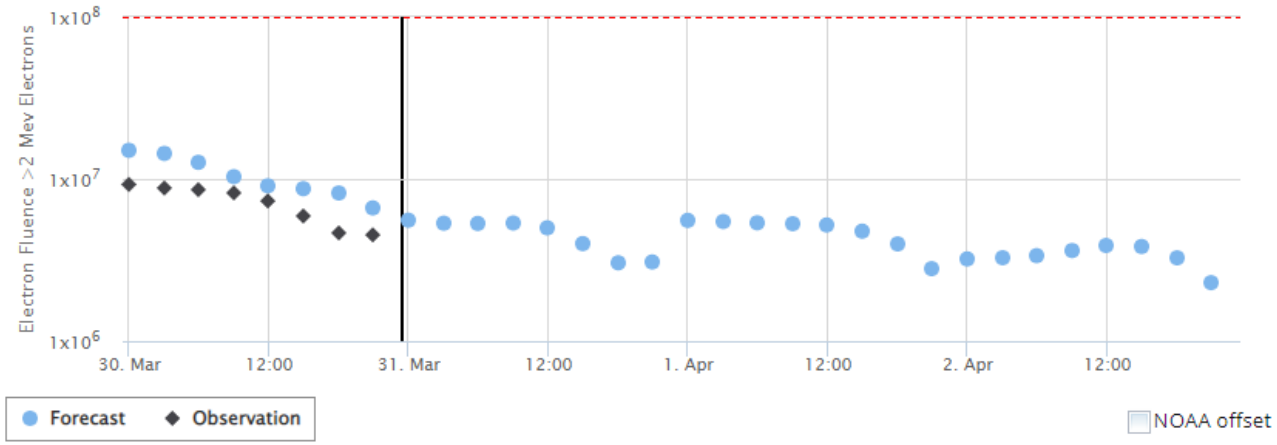
High Energy Electrons Event (≥ 2MeV):
The high energy (greater than 2 MeV) electron flux, as observed by GOES-16 at GEO, was at background to moderate levels, with a peak of 243pfu at 30/1540 UTC. A flat trend is expected at first. However, from Day 1 (31st March) confidence becomes low, as the 28th March CME(s) are expected to arrive at Earth, and this is likely to at least temporarily reduce flux levels. Thereafter, some erratic fluctuation is likely, but with a possible eventual rise towards the end of the period.

The 24 hour fluence is likely to remain below the Active (1e8 integrated pfu) threshold for much of the period. REFM is considered to be giving reasonable guidance in the short term with a flat trend, but will not reflect the anticipated CME influences from Day 1 (31st).

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}\,sr^{-1}\,day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	20	30	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	5	5

Figure 8: REFM electron fluence – observations and forecast.



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